1) The electronic polarizability of the Ar atom has a value of $1.7*10^{-40}$ F m^2. What is the static dielectric constant of the solid Ar if its density is 1.8 g cm^{-3} and its atomic mass is 39.95 g mol^{-1}? (Avogadro's number = $6.02*10^{23}$ mol^{-1}).

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2) Consider a CsCl crystal which has CsCl unit cell crystal structure (one Cs^+_Cl^- pair per unit cell) with a lattice parameter (a) of 0.412 nm. The electronic polarizability of Cs^+ and Cl^- ions are $3.35*10^{-40}$ F m^2 and $3.4*10^{-40}$ F m^2 respectively, and the mean ionic polarizability per ion pair is $6*10^{-40}$ F m^2. What is the dielectric constant? (Given that $N = I/a^3$).

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3) In a certain atom, the positive charge in the nucleus has a value of $q=3.2*10^{-19}$ C, the radius of the atom $R=6*10^{-9}$ cm, E=20 KV/cm and $N= 3*10^{19}$ cm^{-3}. Find the equilibrium distance d_E, the dielectric susceptibility and diclectric constant resulting from electronic polarization.

4) An atom with a radius of $5*10^{-8}$ cm has a positive charge in the nucleus with a magnitude of $4*10^{-18}$C. If the atom is subjected to an electrical field of 15KV/cm, calculate the equilibrium distance "d" according to the electronic polarization assuming a number of molecules per unit volume of $25*10^{20}$. Calculate also the electric dipole moment, the polarization, the dielectric susceptibility and the dielectric constant after equilibrium.

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5) Find the polarizability of a certain ion in Fm^2 assuming that the number of molecules per unit volume is $22*10^{18}$ cm^{-3}. The dielectric constant of the ion is 4.

$\alpha = \frac{3}{N} = 22*10^{18}$

$\varepsilon_r = 4$

$\frac{\varepsilon_r - 1}{\varepsilon_r + 2} = \frac{N\alpha}{3\varepsilon_0}$

$\alpha = 6.634 * 10^{-37}$ Fm^2

1) For the orientation polarization with sinusoidal applied field, find the expressions for ε_r' and ε_r''.

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2) With the help of equations 1-6, 1-8 and 2-4, derive equations to describe the variation of the dielectric constant with frequency. Assume that $\alpha_0 = 6*10^{-36}$ F m^2 and $N=25*10^{22}$ m^{-3}. Plot this variation when the frequency varies in the range from $0.001/\tau$ to $1000/\tau$.

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3) Obtain the dielectric loss per unit capacitance in a capacitor in terms of the loss tangent. Obtain the phase difference between the current through the capacitor and that through R_p. What is the significance of δ?

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4) Calculate the power dissipated per unit volume of cross-linked polyethylene, XLPE (typical power cable insulator) at 60 Hz at a field of 100 kV cm^{-1} if ε_r' and tan δ of XLPE are 2.3 and $3 * 10^{-4}$ respectively.